MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

PEL0016 – ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

2 MARCH 2018
9:00 A.M. - 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 7 printed pages.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

ANSWER ALL QUESTIONS

QUESTION 1 (15 MARKS)

a) Three parallel conducting wires, with their location, in meter, are shown in **Figure Q1(a)**. Given the net magnetic field, B_{net} at point P is 30° with respect to -y-axis.

i) Determine the direction of current in wire 1, I_1.
[Hint: sketch all possible direction(s) of magnetic field from each wire which passes though point P] [2 marks]

ii) Obtain magnitude of current I_1.
[Hint: use direction of B_{net} as reference, where tangent function is negative for second and fourth quadrant] [4 marks]

iii) From (ii), calculate the magnitude of net magnetic field at point P, B_{net}. [3 marks]

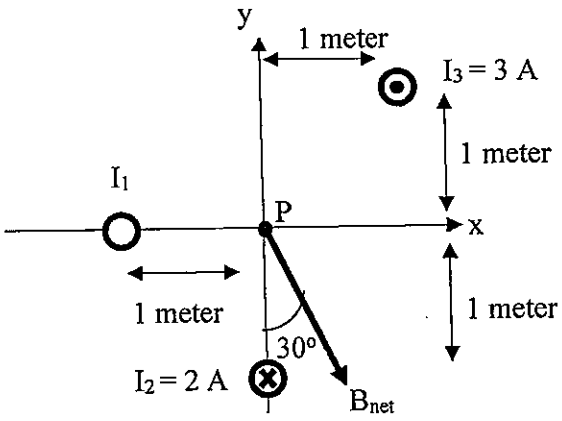

Figure Q1(a)

b) A single coil is attached to the *y-axis*, where it is freely to move about *y-axis* as shown in **Figure Q1(b)**.

i) Determine the direction of movement of the coil as seen from the *+y-axis* (either clockwise or counter clockwise direction), if the magnetic field, *B* is moving in the direction of towards negative *z-axis*.
[Hint: you may re-draw the diagram for understanding] [1 mark]

ii) If the amount of magnetic field, *B* is *5.0 T*, while the current, *I* is *2.0 A* and the area of the coil is *0.5 m²*, calculate the torque, τ of coil. [1 mark]

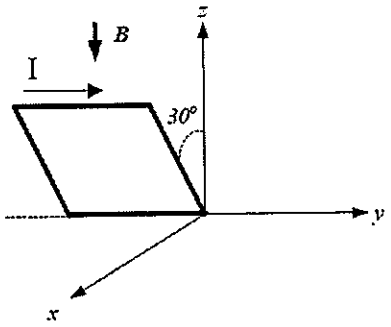

Figure Q1(b)

Continued...

c) The rotational system used to generate the induced voltage is as shown in **Figure Q1(c)**. The coil is fixed about x-axis. External magnetic field move along +y-axis, with magnitude 0.6 T. The coil has edge of 60 cm in length and contains 6 turns. It rotates with angle $\beta = 60^{\circ}$ within 0.6 s.

i) Obtain the change in magnetic flux through the coil. [1 mark]
[Hint: angle is measured between normal towards direction of magnetic field]

ii) Determine the induced e.m.f. in the coil. [1 mark]

iii) Obtain the direction of induced current in the coil, (either clockwise or counter clockwise direction) as seen from P, as the coil rotates. Explain your answer. [2 marks]

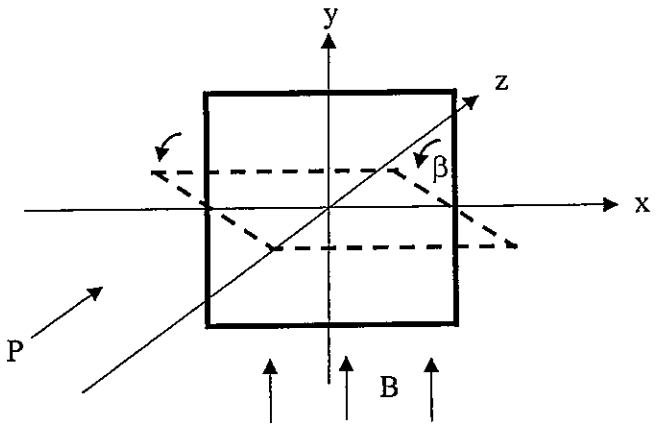

Figure Q1(c)

Continued...

QUESTION 2 (15 MARKS)

Figure Q2(a) below shows a combination of resistors in a circuit diagram. **Figure Q2(b)** shows Norton equivalent circuit of the original circuit in **Figure Q2(a).** Given $R_L = R_1$,

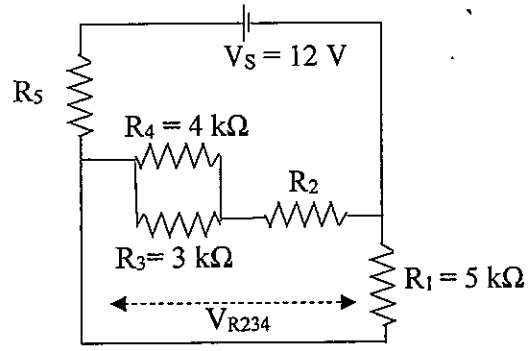

Figure Q2(a)

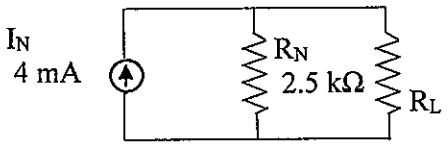

Figure Q2(b)

i) Obtain the value of resistors R_2 and R_5. [Hint: solve for I_N then solve for R_N] [3 marks]

ii) Find equivalent resistance of combination resistors R_2, R_3 and R_4, R_{234}. [1 mark]

iii) From (ii), obtain voltage V_{R234} using voltage divider rule only. [Hint: sketch the combination of R_{234} as an aid] [2 marks]

iv) From (iii), obtain current across resistor R_2, I_{R2}. [1 mark]

v) From (iv), obtain current across resistor R_3, I_{R3} using current divider rule only. [1 mark]

vi) Using Kirchhoff's laws, prove current across resistor R_2, I_{R2} is the same as in (iv). [Hint: use combination resistors R_{234} in (iii)] [7 marks]

Continued...

QUESTION 3 (10 MARKS)

In an RLC series circuit with the AC source of 240 V, it is found that the reactive power is 89 W, while the phase angle is 20° and voltage across the inductor, V_L is 140 V, as shown in **Figure Q3.**

i) Calculate net reactance, X_L-X_C, [Hint: use reactive power.] [2 marks]

ii) From (i), obtain current, I. [1 mark]

iii) From (ii), obtain reactance of capacitor, X_L. [1 mark]

iv) From (iii), obtain X_C . [1 mark]

v) From (ii), obtain impedance, Z. [1 mark]

vi) Calculate resistance, R. [2 marks]

vii) Sketch the phasor diagram showing relationship between impedance and the reactance. [2 marks]

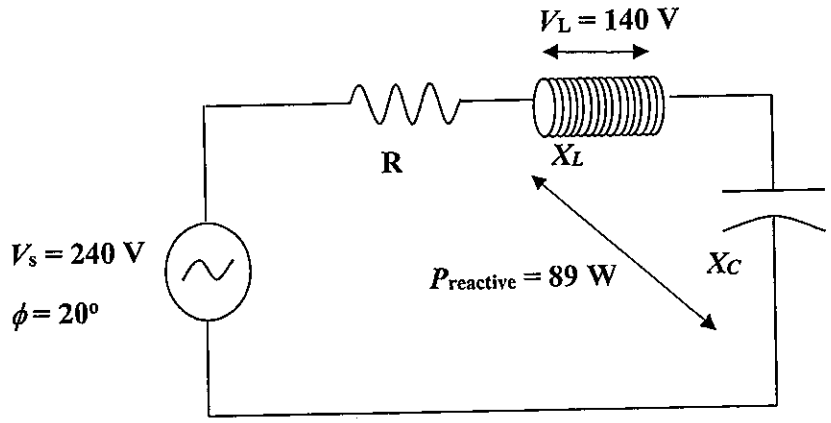

Figure Q3

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QUESTION 4 (10 MARKS)

a) Define the following terms accordingly:
   i) Conduction band [1 mark]
   ii) Depletion region [1 mark]

b) Explain the formation of depletion region in PN junction. [2 marks]

c) Sketch the atomic structure for intrinsic semiconductor after being doped with pentavalent atom. Mention type of pentavalent atom used. Label the atomic structure accordingly.
[2 marks]

d) Determine I_B, I_E and V_E in **Figure Q4** , given that $\beta_{dc} = 100$. Assume that the transistor is made of Silicon.
[Hint: start by determining the base, collector and emitter terminals.]
[4 marks]

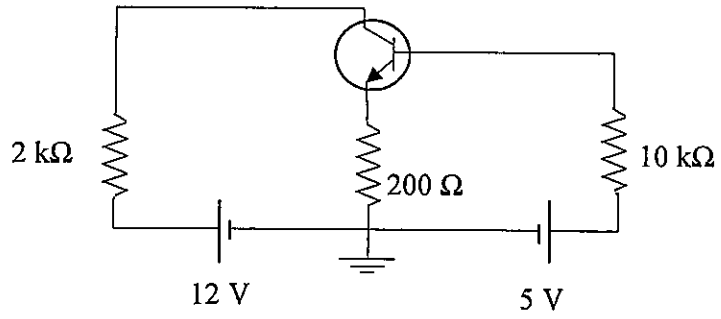

Figure Q4

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APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2/kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.81 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	8.988×10^9 N m^2/C^2
Permittivity of free space	ε_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:
One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc}+1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 nI$$

$$\xi = V + Ir$$

$$\xi = blv$$

$$\xi = -N\frac{\Delta\Phi}{\Delta t}$$

$$\xi = -L\frac{dI}{dt}$$

$$\xi = -M\frac{dI}{dt}$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max}\sin\omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x}\right)I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_o N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$P_t = I_{rms}V_{rms}\cos\phi$$

$$P_r = V_{rms}I_{rms}\sin\phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0[1 + \alpha(T - T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA\sin\theta$$

$$U = \frac{1}{2}LI^2$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$V_H = Bvd$$

$$V = V_{max}\sin\omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T}\right)V_S$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B.dl = \mu_o I$$

$$d\mathbf{B} = \frac{\mu_O I}{4\pi}\frac{d\ell \times \hat{\mathbf{r}}}{r^2}$$

$$\Phi_B = BA\cos\theta$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$